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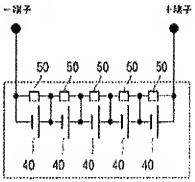
(54) SECONDARY BATTERY EQUIPPED WITH CURRENT BYPASS CIRCUIT

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a secondary battery producing an optimum charging environment.
SOLUTION: In the secondary battery formed by connecting a plurality of unit batteries 40 in series, a bypass circuit element 50 connecting a positive electrode and a negative electrode by bypassing an electrolyte interposed between the positive electrode and the negative electrode in a case where the voltage of the unit batteries 40 exceeds a specified value is connected to between the positive electrode and the negative electrode of the unit batteries 40.



* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1]
Are two or more cells a rechargeable battery connected in series, and between a cathode of said cell, and an anode, A rechargeable battery provided with a current bypass circuit connecting a current bypass circuit which bypasses an electrolyte which intervenes between said cathode and an anode, and connects said cathode and an anode when voltage of said cell exceeds default value.
[Claim 2]
Are two or more cells a rechargeable battery connected in series, and said cell, On both sides of a cell layer with structure where an electrolyte was made to intervene between a cathode and an anode, it is constituted from the cathode and anode side by charge collector, and between a charge collector by the side of a cathode of said cell, and a charge collector by the side of an anode, A rechargeable battery provided with a current bypass circuit connecting a current bypass circuit which bypasses said electrolyte and connects said cathode and an anode when voltage of said cell exceeds default value.
[Claim 3]
Make an electrolyte intervene, connect with two or more series and a bipolar electrode in which a cathode was formed in one field of a charge collector, and an anode was formed in a field of another side between said charge collectors, A rechargeable battery provided with a current bypass circuit connecting a current bypass circuit which bypasses said electrolyte and connects said cathode and an anode when voltage of a cell formed between said charge collectors exceeds default value.
[Claim 4]
A rechargeable battery provided with the current bypass circuit according to claim 2 or 3, wherein said current bypass circuit has an interval of two charge collectors, and the thickness of an identical size and is formed on said charge collector.
[Claim 5]
A rechargeable battery provided with the current bypass circuit according to any one of claims 1 to 3, wherein said current bypass circuit is connected to said cathode and an anode within a sealing agent of said rechargeable battery.
[Claim 6]
A rechargeable battery provided with the current bypass circuit according to claim 2 or 3, wherein said some of charge collectors are exposed from a sealing agent of said rechargeable battery and said current bypass circuit is connected to two exposed charge collectors.
[Claim 7]
A rechargeable battery provided with the current bypass circuit according to any one of claims 1 to 3 providing said current bypass circuit separately to all the cells with which said rechargeable battery is provided.
[Claim 8]
A rechargeable battery provided with the current bypass circuit according to any one of claims 1 to 3 providing said current bypass circuit separately to a settlement of the arbitrary number of a cell with which said rechargeable battery is provided.
[Claim 9]
A rechargeable battery provided with the current bypass circuit according to any one of claims 1 to 3, wherein said current bypass circuit contains a zener diode by which the both ends are connected to said cathode and an anode.
[Claim 10]
A rechargeable battery provided with the current bypass circuit according to any one of claims 1 to 3, wherein said current bypass circuit includes a series circuit of a zener diode and a resistor by which the both ends are connected to said cathode and an anode.
[Claim 11]
A rechargeable battery which equipped said cathode with the current bypass circuit according to any one of claims 1 to 3 characterized by using carbon or a lithium transition metal compound ghost for said anode as an active material using a lithium transition metal compound ghost as an active material.
[Claim 12]
A rechargeable battery provided with the current bypass circuit according to any one of claims 1 to 3 using either a gel electrolyte or an intrinsic polymer electrolyte for said electrolyte.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]
This invention relates to the rechargeable battery provided with the current bypass circuit which can make the optimal charge environment itself.
[0002]
[Description of the Prior Art]
Development of the rechargeable battery which can be charged is also becoming active as development of an electromobile prospers in recent years. Also in a rechargeable battery, since especially a lithium cell is a highly efficient cell with the features, such as small size, a light weight, and high energy density, it is suitable as a cell carried in an electromobile.
[0003]
The lithium cell of a bipolar type has also in it the structure where many cells which are one power generation element were laminated by series. Therefore, charge will be performed where many cells are connected in series. Although the cell of structure laminated or connected exists many cells in series besides a bipolar battery, as for this cell, charge is performed where a cell is connected in series. The cell written in this Description has referred to each power generation element which constitutes one cell.
[0004]
[Problem to be solved by the invention]
Thus, when charging if battery characteristics, such as cell capacity of each cell and internal resistance, have dispersion since two or more cells are connected in series inside the bipolar battery, there is a problem that each cell cannot charge uniformly.
[0005]
For example, in the case of a lithium cell, the maximum charge voltages are strictly specified as 4.2V, and if the voltage between lithium cell terminals reaches these maximum charge voltages at the time of charge, charge will be ended immediately.
[0006]
However, when the cell capacity of each cell has dispersion, even if a cell with small cell capacity reaches a full charge state, the cell with larger cell capacity than the cell is still in an insufficient charging state. Since charge is continued if the voltage between bipolar battery terminals has not reached the maximum charge voltages even if it is in such a state, the cell with small cell capacity will be in an overcharging condition.
[0007]
Since the charging current of the same size as all the cells flows when the internal resistance of a cell has dispersion, the charge voltages of a cell with big internal resistance become larger than the charge voltages of the cell whose internal resistance is smaller than the cell. Therefore, it will be in a various charging state for every cell.
[0008]
Usually, since the optimal charge-voltages range of a lithium cell is provided about **0.1V and in the very narrow range, dispersion in the charge voltages which each cell is allowed is dramatically small. The device in a manufacturing stage, such as controlling the thickness of the coating thickness of a positive/negative electrode, a charge collector, and a solid electrolyte by high degree of accuracy, is also performed so that the cell capacity and internal resistance of a cell may become uniform, but it is difficult to equalize the battery characteristic of each cell thoroughly at present.
[0009]
This invention is accomplished in order to cancel the problem of the above Prior arts, It aims at offer of the rechargeable battery provided with the current bypass circuit which can absorb the unevenness of battery characteristics, such as cell capacity of a cell, and internal resistance, can make the optimal charge environment itself, and can prolong a battery life.
[0010]
[Means for solving problem]
In order to solve above-mentioned SUBJECT and to attain the purpose, the rechargeable battery provided with the current bypass circuit concerning this invention, It is a rechargeable battery which connects two or more cells in series, and when the voltage of said cell exceeds default value between the cathode of said cell, and an anode, the current bypass circuit which bypasses the electrolyte which intervenes between said cathode and an anode, and connects said cathode and an anode is connected.
[0011]

If the charge voltages of a cell exceed default value at the time of charge, a bypass circuit will bypass the electrolyte which constitutes a cell and will carry out direct continuation of the cathode and anode of the cell. For this reason, when the charge voltages of a cell reach default value, charge of that cell is completed.

[0012]

Thus, if the charging current bypass circuit aiming at the prevention from overcharge of a cell is installed, the charging state of each cell can be arranged by the full charge side, and the variation in a charging state can prevent some cells from being in an overcharging condition.

[0013]

[Effect of the Invention]

Since according to the rechargeable battery provided with the current bypass circuit of this invention the electrolyte was bypassed when the voltage of a cell exceeded default value, even if battery characteristics, such as cell capacity of a cell and internal resistance, vary, the charging state of the cell which constitutes a rechargeable battery can be arranged.

[0014]

[Mode for carrying out the invention]

With reference to an accompanying drawing, the suitable embodiment of the rechargeable battery provided with the current bypass circuit concerning this invention is described in detail below. In this embodiment, a bipolar rechargeable lithium-ion battery is mentioned as an example, and is explained.

[0015]

Drawing 1 to drawing 7 is a figure with which explanation of the internal structure of the bipolar rechargeable lithium-ion battery provided with the current bypass circuit is presented. The bipolar electrode 10 which has section structure as shown in drawing 1 is used for the bipolar rechargeable lithium-ion battery concerning this invention. The cathode 14 is formed in one field of the charge collector 12 at the bipolar electrode 10, and the anode 16 is formed in the field of another side. The current bypass circuit element 50 is formed in the upper part of the charge collector 12 at the bipolar electrode 10.

[0016]

The cathode 14 applies a cathode slurry to one side of SUS foil with a thickness of about 20 micrometers which constitutes the charge collector 12, is made to harden it by thermal polymerization, and is formed. A cathode slurry as positive active material A lithium transition metal compound ghost, for example, $LiMn_2O_4$, What replaced some of $LiCoO_2$, $LiNiO_2$, or these transition metals with other elements, As polymer acetylene black as an electric conduction auxiliary agent polyethylene oxide (PEO), It is considered as a supporting electrolyte, and as a slurry viscosity adjustment medium, azobisuisobutironitoriru is mixed by a predetermined ratio as a polymerization initiator, respectively, and $Li(C_2F_5SO_2)_2N$ is created for NMP.

[0017]

The anode 16 applies an anode slurry to the opposite side of the SUS foil which applied the cathode 14, is made to harden it by thermal polymerization, and is formed. An anode slurry as negative electrode active material Hard carbon, graphite, Carbon or a lithium transition metal compound ghost, for example, $Li_4Ti_5O_{12}$, As polymer acetylene black as an electric conduction auxiliary agent polyethylene oxide (PEO), It is considered as a supporting electrolyte, and as a slurry viscosity adjustment medium, azobisuisobutironitoriru is mixed by a predetermined ratio as a polymerization initiator, respectively, and $Li(C_2F_5SO_2)_2N$ is created for NMP. The above materials are used for the cathode 14 and the anode 16 because such materials are excellent in reactivity and cycle durability and low cost.

[0018]

It is because such materials have good reactivity, it is excellent in the cycle durability of charge and discharge to have adopted such materials as the cathode 14 and the anode 16 and it is moreover low cost. Therefore, the bipolar rechargeable lithium-ion battery using such materials is excellent in output characteristics, and, moreover, will become inexpensive.

[0019]

An electrolyte membrane will be formed in the outside surface of the cathode 14 and the anode 16 if the cathode 14 and the anode 16 are formed in each field of the charge collector 12.

[0020]

As shown in the bipolar rechargeable lithium-ion battery concerning this invention at drawing 1 and drawing 2, the current bypass circuit element 50 is formed in the upper part of the charge collector 12. The current bypass circuit element 50 is the circuit which connected the zener diode 52 and the resistor 54 in series as shown in drawing 3 equivalent. The current bypass circuit element 50 may be directly formed in the charge collector 12 using publicly known semiconductor manufacturing technology, and the current bypass circuit element 50 created beforehand may be attached to the charge collector 12 with electroconductive glue.

[0021]

When creating a bipolar rechargeable lithium-ion battery, it laminates, but the bipolar electrode 10 forms the current bypass circuit element 50 so that it may become the interval of two charge collectors and the thickness of an identical size which were laminated.

[0022]

Since the current bypass circuit element 50 makes the current at the time of charge bypass when zener voltage is exceeded, it attaches the resistor 54 to the field in which the cathode 14 of the charge collector 12 is formed.

[0023]

Although the current bypass circuit element 50 was made into the circuit which connected the zener diode 52 and the resistor 54 in series, only a zener diode may constitute from this embodiment. However, it is more desirable to have the resistor 54 which can suppress the increase in the current to some extent so that excessive current may not flow into the

current bypass circuit element 50 since the charging current of a bipolar rechargeable lithium-ion battery increases when the current bypass circuit element 50 bypasses current. The size that the current through which the resistance of a resistor flows into the current bypass circuit element 50 does not become excessive is chosen.

[0024]

As shown in drawing 4, two or more bipolar electrodes 10 which have the above composition are laminated so that each cathode 14 and anode 16 may counter on both sides of the electrolyte 20.

Either a gel electrolyte or an intrinsic polymer electrolyte can be used for the electrolyte 20. As an intrinsic polymer electrolyte, PEO, PPO(s), and these copolymers can be used, for example. If either a gel electrolyte or an intrinsic polymer electrolyte is used, there are no worries about liquid leakage and a bipolar rechargeable lithium-ion battery can be formed with simple composition as compared with a case where a liquid is used for an electrolyte. Since a problem of liquid junction will not arise if a polymer of solid states, such as a gel electrolyte or an intrinsic polymer electrolyte, is used, it is reliable and a rechargeable battery excellent in output characteristics can be constituted.

[0025]

Since the current bypass circuit element 50 is formed in thickness which totaled the cathode 14, the anode 16, and the electrolyte 20, the zener diode 52 of the current bypass circuit element 50 contacts the next charge collector 12 in a process in which the bipolar electrode 10 is laminated. If electrooonductive glue is applied to the charge collector 12 of a direction where the zener diode 52 contacts when laminating the bipolar electrode 10, the current bypass circuit element 50 is connectable between the two charge collectors 12 only by laminating the bipolar electrode 10 and going at the time of manufacture of a cell. That is, the current bypass circuit element 50 will be connected simultaneously with lamination of the bipolar electrode 10. Therefore, the current bypass circuit element 50 will connect the cathode 14 of one charge collector 12, and the anode 16 of the charge collector 12 of another side.

[0026]

Thus, if it enables it to connect the current bypass circuit element 50 between the charge collectors 12 only by laminating the bipolar electrode 10, The current bypass circuit element 50 can be easily stored in the inside of a rechargeable battery, and the function which controls the charging state of a rechargeable battery can be incorporated, without changing the size of a rechargeable battery.

[0027]

As mentioned above, if the electrolyte 20 is made to intervene, it connects with 5 pole series and the bipolar electrode 10 is packed with the sealing agent 60, it will become the bipolar rechargeable lithium-ion battery 100 of a layer system as shown in drawing 5 by which the current bypass circuit element 50 was incorporated in the cell. Therefore, it will be connected to the cathode 14 and the anode 16 inside the sealing agent 60, and the current bypass circuit element 50 can be used as the cell of compact composition. The anode 16 is formed only in one field at the charge collector 70 used as - terminal of the bipolar rechargeable lithium-ion battery 100, and the cathode 14 is formed only in one field at the charge collector 80 used as the + terminal.

[0028]

In the layer system of the bipolar rechargeable lithium-ion battery 100 shown in drawing 5, as shown in drawing 6, the layer system of the anode 16-electrolyte 20-cathode 14 is formed in the two charge collectors 12, but on these Descriptions, this layer system is called the cell layer 30. Although it becomes one power generation element with the charge collector 12-cell layer 30-charge collector 12, since it is possible that this power generation element is a still smaller cell which constitutes the bipolar rechargeable lithium-ion battery 100, on these Descriptions, this power generation element is called the cell 40.

[0029]

If the name of a layer system is attached as shown in drawing 6, as shown in the equivalent circuit of drawing 7, two or more cells can consider the bipolar rechargeable lithium-ion battery 100 shown in drawing 5 to be the cell connected in series. The current bypass circuit element 50 is separately formed to all the cells 40, and the current bypass circuit element 50 bypasses the current at the time of the charge which passes the cell 40, when the voltage of each cell 40 exceeds the zener voltage specified with the zener diode 52.

[0030]

It explains referring to drawing 7 for the operation at the time of charge of the bipolar rechargeable lithium-ion battery 100 constituted as mentioned above. When charging the bipolar rechargeable lithium-ion battery 100, + terminal of the battery charger which is not illustrated is connected to + terminal of the bipolar rechargeable lithium-ion battery 100, and - terminal of a battery charger is connected to - terminal of the bipolar rechargeable lithium-ion battery 100, respectively. The charge voltages which a battery charger impresses to ** both the terminals of the bipolar rechargeable lithium-ion battery 100, For example, if the charge voltages of each cell 40 are set as 4.0V, it is 4.0(charge voltages of one cell)x5(number of cell 40 which bipolar rechargeable lithium-ion battery 100 has)=20.0V.

[0031]

If a battery charger is connected to the bipolar rechargeable lithium-ion battery 100 and charge voltages are impressed, the same current decided by internal resistance of the bipolar rechargeable lithium-ion battery 100 will flow into all the cells. For example, supposing the internal resistance of the five cells 40 is R_1, R_2, R_3, R_4, and R_5. The internal resistance R of the bipolar rechargeable lithium-ion battery 100 becomes $R_1+R_2+R_3+R_4+R_5$. In this case, if the charge voltages impressed by a battery charger are set to V, the charging current of $I=V/(R_1+R_2+R_3+R_4+R_5)$ will flow into all the cells 40. The cell 40 is charged by this charging current.

[0032]

Since the size of the internal resistance of each cell 40 has dispersion in the above-mentioned case, the charge voltages

impressed every cell 40 differ. For example, the charge voltages of IR_3V will be impressed to the cell 40 with which the charge voltages of IR_1V have the resistance of R_3 in the cell 40 with the resistance of R_1, respectively. Therefore, a charging state becomes various with the cell 40.

[0033]

Although the current bypass circuit element 50 is connected in parallel with each cell 40, with the current bypass circuit element 50, the zener diode 52 is connected in the direction which prevents conduction. Since the charge voltages of each cell 40 do not reach zener voltage (voltage which the zener diode of the current bypass circuit element 50 conducts) at the beginning when charge was started, current hardly flows into the current bypass circuit element 50.

[0034]

When the voltage exceeds zener voltage, the current which the zener diode of the current bypass circuit element 50 conducts, and flows into the cell 40 is made for the voltage between terminals of each cell 40 to rise, if charge progresses, but to bypass. For example, if zener voltage uses the zener diode 52 which is 4.0V, when the voltage between terminals is set to 4.0V, charge of the cell 40 will finish.

[0035]

Charge is ended automatically, and when all the current bypass circuit elements 50 bypass the cell 40, charge of the bipolar rechargeable lithium-ion battery 100 ends the cell 40 with which the voltage between terminals reached charge voltages. Where all the cells 40 are bypassed, the current supplied to the five current bypass circuit elements 50 connected in series from a battery charger flows, but the current at this time is restricted by the resistor 51 connected with the zener diode 52 in series.

[0036]

As mentioned above, in the rechargeable battery provided with the current bypass circuit concerning this invention. Since the current bypass circuit will operate and charge will be terminated if the charge voltages of a cell exceed default value, even if battery characteristics, such as cell capacity of a cell and internal resistance, are uneven, the uniform and optimal charge environment can be made itself. Since it will not be in the charging state partial for every cell but uniform charge can be performed, the life as a cell improves and it becomes a reliable cell.

[0037]

Although an above embodiment explained the case where the current bypass circuit element 50 was attached to the cathode 14 and the anode 16 inside the sealing agent 60, it may be made to form the current bypass circuit element 50 in the exterior of the sealing agent 60, as shown in drawing 8. In this case, as shown in a figure, some charge collectors 12 are exposed from the sealing agent 60, and the posterior matter of the current bypass circuit element 50 is carried out between the charge collectors 12 from the outside of the sealing agent 60.

[0038]

Thus, if it enables it to post-install the current bypass circuit element 50 from the outside of a cell, the size of the current bypass circuit element 50 and the flexibility of form increase, and the circuit can be constituted simply and inexpensive. It also becomes possible to constitute the circuit according to the function demanded.

[0039]

For example, the voltage detecting element 56 may be made to build in further, as the current pie path circuit 50 is shown in drawing 9 rather than is formed by the series circuit of a zener diode or a zener diode, and a resistor as mentioned above. The voltage detecting element 56 is a circuit element containing a comparator, and outputs a signal, comparing the terminal voltage of the series circuit of the zener diode 52 and the resistor 54 with charge final voltage. Charge of the cell 40 progresses, and if the voltage between the terminal rises and charge final voltage is reached, the zener diode 52 will conduct. Although the charge to the cell 40 is ended by this conduction, as for the voltage between terminals of the series circuit of the zener diode 52 and the resistor 54, charge final voltage is maintained. If the voltage detecting element 56 reaches charge final voltage, a signal will be outputted from the comparator built in the voltage detecting element 56. The signal from a comparator is outputted towards the charge control element with which a battery charger is provided and which is not illustrated. It can be judged whether charge of all the cells 40 which constitute the bipolar rechargeable lithium-ion battery 100 ended the battery charger with this signal, If the end of charge of all the cells 40 is checked, operation of a battery charger can be stopped automatically (if it checks that the signal is outputted from all the voltage detecting element 56).

[0040]

Like the above-mentioned embodiment, drawing 10 forms the current pie path circuit 50 every cells 40 of not all, but forms the one current bypass circuit element 50A to the cell 40A connected to two series in the inside of the bipolar rechargeable lithium-ion battery 100. Thus, since it will be set to one half when the number of the required current bypass circuit elements 50A provides every cells 40 of all the if one current bypass circuit is provided to the two cells 40, a cost cut can be aimed at.

[0041]

Although the one current bypass circuit element 50A was formed to the two cells 40 in the above-mentioned example, as it was not restricted to this but was called a three-piece unit and a four-piece unit, it is also possible to provide separately to a settlement of the arbitrary number of the cell with which the bipolar rechargeable lithium-ion battery 100 is provided.

[0042]

Drawing 11 prepares the current bypass circuit element 50B for each group of the unit cell group divided into two groups in the exterior of the bipolar rechargeable lithium-ion battery 100.

[0043]

Selection whether to provide outside whether is one current bypass circuit provided to how many cells, or a current bypass

circuit is established in the inside of a cell, The dispersion condition of the battery characteristic of the cell which constitutes the bipolar rechargeable lithium-ion battery 100, and the grade of battery capacity demanded are taken into consideration and decided.

[0044]

Two or more series parallel connection of the bipolar rechargeable lithium-ion battery 100 concerning this invention is carried out, and as shown in drawing 12, it is carried in the under floor part of vehicles as the cell group 200. This cell group 200 is used as a power supply for a drive of an electromobile or a hybrid electric vehicle. The setting position of the cell group 200 can be installed not only in an under floor part but in the inside of Amai in an engine room.

[0045]

Since all the cells change into a full charge state even if the bipolar rechargeable lithium-ion battery 100 concerning this invention has dispersion in the cell capacity and internal resistance of a cell, it can demonstrate battery capacity to the maximum extent. Therefore, if the bipolar rechargeable lithium-ion battery 100 concerning this invention is used, high capacity and the high-output cell group 200 can be constituted, and if this cell group 200 is carried, the electromobile excellent in startability can be provided.

[Brief Description of the Drawings]

[Drawing 1]It is a figure showing the section structure of a bipolar electrode.

[Drawing 2]It is a top view of a bipolar electrode.

[Drawing 3]It is a figure with which composition explanation of a current bypass circuit element is presented.

[Drawing 4]It is a figure showing the laminating condition of a bipolar electrode.

[Drawing 5]It is a figure showing the internal structure of a bipolar rechargeable lithium-ion battery.

[Drawing 6]It is a figure with which explanation of the layer system of the bipolar rechargeable lithium-ion battery shown in drawing 5 is presented.

[Drawing 7]It is a figure showing the equivalent circuit of the bipolar rechargeable lithium-ion battery shown in drawing 5.

[Drawing 8]It is an outline block diagram of the bipolar rechargeable lithium-ion battery with which the current bypass circuit element is attached outside the sealing agent.

[Drawing 9]What was shown in drawing 3 is a figure showing the current bypass circuit element of a different structure.

[Drawing 10]It is a block diagram at the time of attaching a current bypass circuit element per two or more cells within a sealing agent.

[Drawing 11]It is a block diagram at the time of attaching a current bypass circuit element per two or more cells outside a sealing agent.

[Drawing 12]It is an explanatory view in the case of attaching to vehicles the cell group which connects two or more bipolar rechargeable lithium-ion batteries concerning this invention.

[Explanations of letters or numerals]

10 -- Bipolar electrode
12 -- Charge collector,
14 -- Cathode,
16 -- Anode,
20 -- Electrolyte,
30 -- Cell layer,
40 -- Cell,
50 -- Current bypass circuit element,
52 -- Zener diode,
54 -- Resistor,
56 -- Voltage detecting element,
60 -- Sealing agent,
70, 80 -- Charge collector,
100 -- Bipolar rechargeable lithium-ion battery,
200 -- Cell group.

[Translation done.]